National Aeronautics and Space Administration

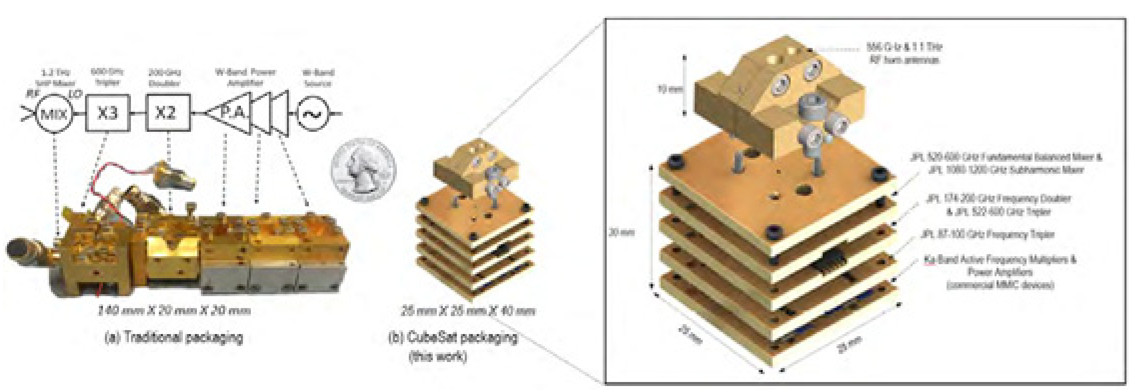
NASA**facts**

Highly Integrated THz Receiver Systems for Small Satellite Remote Sensing Applications

Miniaturizing Dual-band Coherent Receivers for Remote Sensing from CubeSats

We are developing miniaturized, highly integrated Schottky receiver systems suitable for use in CubeSats or other small spacecraft platforms, where state-of-the-art performance and ultra-low mass, power, and volume are required. Current traditional Schottky receivers are too large to employ on a CubeSat. We will develop highly integrated receivers operating from 520-600 GHz and 1040-1200 GHz that are based on state-of-the-art receivers already developed at Jet Propulsion Laboratory (JPL) by using novel 3D multi-layer packaging. This process will reduce both mass and volume by more than an order of magnitude, while preserving state-of-the-art noise performance. The resulting receiver systems will have a volume of approximately 25 x 25 x 40 millimeters (mm), a mass of <250 grams (g), and power consumption on the order of of 7 watts (W). Using these techniques, we will also integrate both receivers into a single frame, further reducing mass and volume for applications where dual band operation is advantageous. Additionally, as Schottky receivers offer significant gains in noise performance when cooled to ~100 K, we will investigate the improvement gained by passively cooling these receivers. Work by Sierra Lobo Inc., with their Cryo Cube technology development program, offers the possibility of passive cooling to ~100 K on CubeSat platforms for 1-unit (1U) sized instruments.

There are several scientific applications in astrophysics, planetary science, and Earth observing that could take advantage of such receivers if they could be reduced in size and mass sufficiently to fly on a CubeSat. One primary motivation for all three scientific areas involves the detection of water vapor. Water vapor lines at 557 GHz and in the 1100-1200 GHz bands are excellent diagnostics of water vapor in the interstellar medium, the Earth s atmosphere, and in the atmospheres of other planetary bodies. The 557 GHz spectral band of water was a main target of both the NASA SWAS SMEX mission



(Left) State-of-the-art 1.2 THz receiver demonstrated at JPL. (Right) Ultra-compact dual-band receiver at 556 GHz and 1.1 THz developed for this work.

and ESA s Herschel Space Observatory. Earth observing missions have traditionally been large, costly, multi-purpose missions (e.g. EOS AURA, with the Microwave Limb Sounder (MLS) instrument on board). The MLS used JPL Schottky receivers for measurement of physical atmospheric properties at several frequencies, and these capabilities can be replicated on individual CubeSats with the receivers developed here. Similarly, atmospheric measurement of planetary atmospheres has been of considerable interest. The Microwave Instrument for Rosetta Orbiter (MIRO) instrument on ESA s Rosetta mission was designed to observe water and several other molecular species in the nucleus of Comet 67P Churyumov- Gerasimenko. The latest NASA Discovery call for proposals includes opportunities for many NASA deep space missions with secondary CubeSat payloads. The technology developed here will permit those secondary payloads to perform atmospheric measurements of planetary bodies when instruments on the main payload do not.

The Highly Integrated THz Receiver Systems for Small Satellite Remote Sensing Applications project is led by Arizona State University s (ASU) School of Earth and Space Exploration THz lab. The NASA JPL Submillimeter Wave Advanced Technology group will work with ASU to produce the highly advanced, miniaturized receivers for this project. Sierra Lobo Inc. will work with ASU and JPL to model the performance of receivers developed here in a passively cooled CubeSat platform.

The Highly Integrated THz Receiver Systems for Small Satellite Remote Sensing Applications project is managed and funded by the Small Spacecraft Technology Program (SSTP) within the Space Technology Mission Directorate. The SSTP expands U.S. capability to execute unique missions through rapid development and in space demonstration of capabilities for small spacecraft applicable to exploration, science, and the commercial space sector. The SSTP will enable new mission architectures through the use of small spacecraft with goals to expand their reach to new destinations, and challenging new environments.

For more information about the SSTP, visit:
www.nasa.gov/directorates/spacetech/small_spacecraft/

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